REMARKS

With the present response, Applicants amend claims 1, 6, 9-17, 22, and 24. Such amendments are supported by, e.g., FIG. 1 and pages 7-9 of the specification. Applicants also amend the specification to correct an error of a grammatical nature and to clarify that the solution x is solution x_80, as shown in FIG. 2.

In the outstanding Office Action, the Examiner rejected claims 1-24 under 35 U.S.C. §101 and rejected claims 1-24 under 35 U.S.C. §102(b) as being anticipated by Ushiro, U.S. Patent No. 5,604,911.

Rejection of claims 1-24 under 35 U.S.C. §101

The Examiner asserts that claims 1-24 are directed to an abstract idea and lack a concrete, useful, and tangible result. Applicants respectfully disagree. Original (i.e., unamended, as-filed) independent claims 1, 9, and 17 are similar, and original independent claim 1 will be chosen as representative. Original independent claim 1 recited the following:

> A method to determine a numerical solution of a linear system of equations representing a physical entity, comprising:
>
> generating a mesh representation of the physical entity, the mesh representation comprising mesh elements;
>
> computing a linear system matrix A of coefficients by computing interactions between simple functions defined over sets of mesh elements;
>
> partitioning the mesh representation into a plurality of partitions separated by partition boundaries; and
>
> computing a preconditioner for the coefficient matrix A that is compatible with the linear system of equations and that provides at least basis function support over at least two mesh elements, where coupling of the preconditioner between partitions is only through basis functions at the partition boundaries.

It can be seen that a preconditioner is computed for the matrix A. The preconditioner is a "useful, concrete, and tangible result". State Street Bank & Trust Co. v. Signature Fin. Group, Inc., 47 USPQ2d 1596, 1601 (Fed. Cir. 1996). The preconditioner is useful, as subsequent operations can use the preconditioner, e.g., for determining a numerical solution. The preconditioner is concrete, as it can be viewed or output, if desired. The preconditioner is tangible, as it is an entity for which other items, such as iterative solver of FIG. 1 can use the preconditioner, e.g., for determining the solution x 80.

Furthermore, case law in accord with this analysis. For instance, the court in State Street stated the following:

> However, after *Diehr* [Diamond v. Diehr, 447 U.S. 303, 209 USPQ 1 (1981)] and *Alappat* [In re Alappat, 31 USPQ2d 1545 (Fed. Cir. 1994) (en banc)], the mere fact that a claimed invention involves inputting numbers, calculating numbers, outputting numbers, and storing numbers, in and of itself, would not render it nonstatutory subject matter, unless, of course, its operation does not produce a "useful, concrete and tangible result."

State Street at 1602 (emphasis in original).

There is no doubt that (at least) computing a preconditioner for the matrix A that is compatible with the linear system of equations and that provides at least basis function support over at least two mesh elements , as recited in claim 1, produces "a useful, concrete and tangible result".

The Examiner appears to suggest that there must be a step of ***using*** the preconditioner in order to provide a "tangible result". The court in State Street does state that a "the transformation of data ... constitutes a practical application of a mathematical algorithm, formula, or calculation, because it produces 'a useful, concrete and tangible result'-a final share price momentarily fixed for recording and reporting purposes and even accepted and relied upon by regulatory authorities and in subsequent trades". State Street at 1601. This statement could be construed as implying that the final share price had to be used by regulatory authorities and in subsequent trades. However, the ***independent claim*** involved

in State Street only produced — and did not ***use*** — the final share price. See State Street at 1599, Claim 1.

Furthermore, the following is a claim that was at issue in Alappat:

> A method for use in a telecommunications system in which interexchange calls initiated by each subscriber are automatically routed over the facilities of a particular one of a plurality of interexchange carriers associated with that subscriber, said method comprising the steps of:
>
> *generating a message record for an interexchange call* between an originating subscriber and a terminating subscriber, and *including, in said message record, a primary interexchange carrier (PIC) indicator having a value which is a function of whether or not the interexchange carrier associated with said terminating subscriber is a predetermined one* of said interexchange carriers.

Alappat at 1449 (emphasis in original). Nowhere in this claim does it say that the message record or indicator is ***used***. The message record and indicator are merely generated. Yet, this claim was held valid by the court and was considered to produce a useful result. See Alappat at 1453 ("In contrast, our inquiry here focuses on whether the mathematical algorithm is applied in a practical manner to produce a useful result"); and Alappat at 1453 ("Furthermore, had the [district] court applied the proper analysis to the stated claims, the court would have concluded that all the claims asserted fall comfortably within the broad scope of patentable subject matter under Section 101").

There is no requirement in case law for "using" the preconditioner. Original claim 1 was therefore patentable under §101, as were original independent claims 9 and 17, which recited similar subject matter to the subject matter in original claim 1.

Regardless, in order to further prosecution, Applicant has amended claims 1, 9, and 17 to add subject matter directed to "using" the preconditioner (along with linear system matrix A) in order to determine an approximate numerical solution of the linear system of equations. For instance, amended claim 1 now recites "using at least the linear

system matrix A and the preconditioner, determining an approximate numerical solution of the linear system of equations". Similar subject matter is added to claims 9 and 17.

The amended claims 1, 9, and 17 therefore further clarify that a numerical solution is determined using at least the linear system matrix A and the preconditioner. The determination, using at least the linear system matrix A and the preconditioner, of the approximate numerical solution of the linear system of equations is further evidence of a "concrete, useful, and tangible result".

It is additionally noted that determination of the numerical solution might also be considered a transformation, as a representation of a physical entity is "transformed" into a linear system of equations, an approximate solution of which is determined using the method, computer readable medium and apparatus in claims 1, 9, and 17. Similar transformations have also been approved by the Federal Circuit. For example, the court in State Street also stated the following:

> Today, we hold that the transformation of data, representing discrete dollar amounts, by a machine through a series of mathematical calculations into a final share price, constitutes a practical application of a mathematical algorithm, formula, or calculation, because it produces "a useful, concrete and tangible result"--a final share price momentarily fixed for recording and reporting purposes and even accepted and relied upon by regulatory authorities and in subsequent trades.

State Street at 1601. Furthermore, the Court of Appeals for the Federal Circuit has also stated the following:

> The finding [in Arrhythmia Research Tech. v. Corazonix Corp., 22 USPQ2d 1033 (Fed. Cir. 1992)] that the claimed process "transformed" data from one "form" to another simply confirmed that Arrhythmia's method claims satisfied Section 101 because the mathematical algorithm included within the process was applied to produce a number which had specific meaning -- a useful, concrete, tangible result -- not a mathematical abstraction.

AT&T Corp. V. Excel Communications, 50 USPQ2d 1447,1452 (Fed. Cir. 1999) (citing Arrhythmia at 1039). Therefore, the transformation of amended claims 1, 9, and 17 is further evidence of a "concrete, useful, and tangible result".

With regard to claims 9-16, the Examiner rejected these claims because, the Examiner asserted, the terminology "signal bearing medium" if broadly interpreted includes carrier waves. Applicants respectfully disagree that the terminology "signal bearing medium" does not comport with §101. Nonetheless, to further prosecution, Applicants have amended each of claims 9-16 to replace the terminology "signal bearing medium" with "computer readable medium". See the Interim Guidelines for Examination of Patent Applications for Patent Subject Matter Eligibility:

> In contrast, a claimed ***computer-readable medium*** encoded with a computer program is a computer element which defines structural and functional interrelationships between the computer program and the rest of the computer which permit the computer program's functionality to be realized, and is thus statutory.

Id., 53 (emphasis added) (citation omitted).

For at least these reasons, Applicants respectfully request the §101 rejection to claims 1-24 be withdrawn.

Rejection of Claims 1-24 under 35 U.S.C. §102(b)

The Examiner rejected claims 1-24 under 35 U.S.C. §102(b) as being anticipated by Ushiro. Applicants respectfully disagree. The amendments made herein to the claims were made for purposes other than patentability under §102(b). The arguments herein use the originally filed claims. Consequently, the amended claims should receive their full range of equivalents.

Claim 1 is representative and is chosen for the arguments herein. Original claim 1 recited the following:

generating a mesh representation of the physical entity, the mesh representation comprising mesh elements;

computing a linear system matrix *A* of coefficients by computing interactions between simple functions defined over sets of mesh elements;

partitioning the mesh representation into a plurality of partitions separated by partition boundaries; and

computing a preconditioner for the coefficient matrix *A* that is compatible with the linear system of equations and that provides at least basis function support over at least two mesh elements, where coupling of the preconditioner between partitions is only through basis functions at the partition boundaries.

At least the subject matter of "partitioning the mesh representation into a plurality of partitions separated by partition boundaries" and "computing a preconditioner for the coefficient matrix *A* that is compatible with the linear system of equations and that provides at least basis function support over at least two mesh elements, where coupling of the preconditioner between partitions is only through basis functions at the partition boundaries" is not disclosed by Ushiro.

It is noted, in original claim 1, that a mesh representation of the physical entity is generated. The mesh representation comprises mesh elements. The subject matter of "partitioning the mesh representation into a plurality of partitions separated by partition boundaries" is shown in an example in FIG. 2. FIG. 2 is shown below:

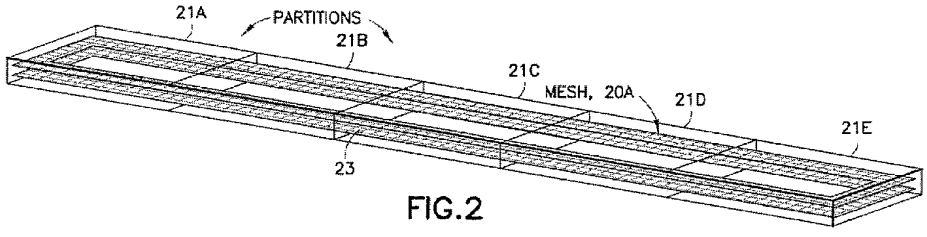


FIG.2

It can be seen that the already created mesh representation is the partitioned into a number of partitions 21A-21E. Subsequently, a preconditioner is computed for the coefficient matrix *A*.

The preconditioner is compatible with the linear system of equations and provides at least basis function support over at least two mesh elements. Coupling of the preconditioner between partitions is only through basis functions at the partition boundaries.

The Examiner cites FIG. 4 and col. 8, lines 32-45 of Ushiro for purported disclosure of the subject matter of "partitioning the mesh representation into a plurality of partitions separated by partition boundaries". Ushiro states the following:

> FIG. 4 shows a procedure of a numerical simulation according to the finite element method. For simplification, there is shown an example of a linear stationary analysis. In a step 13, data items are prepared for the analysis. ***In a step 14, an area for the finite element approximation is partitioned into subareas.*** In a step 15, simultaneous linear equations are generated according to the finite element method. In a step 16, numerical solutions are computed for the linear equations. In this step, the solution of conjugate gradient series with preconditions (FIG. 3) is employed for the computation. Data items resultant from the analysis are desirably presented in a graph (step 17).

Ushiro, col. 8, lines 32-45 (emphasis added). However, the statement "In a step 14, an area for the finite element approximation is partitioned into subareas" does not mean that a mesh representation is partitioned into a number of partitions, as recited in independent claim 1. In fact, this statement merely means that a number of elements as shown in FIG. 5 of Ushiro is formed for a finite element division. Each of the elements might define part of the "subareas", but this is division into many elements is typical in a finite element analysis.

Furthermore, the step 14 in FIG. 4 of Ushiro states "Subdivide Analysis Area into Finite Elements". This statement clarifies that step 14 is merely making elements used for finite analysis from the input area. The statement in Ushiro of "In a step 14, an area for the finite element approximation is partitioned into subareas" simply means that the finite element division shown in FIG. 5 is created.

Ushiro states the following regarding FIG. 5:

> FIG. 5 shows an example of the finite element division. A reference numeral 18 denotes the division of the area into four-node four-edge

> elements and partially into three-node three-edge elements. A reference numeral 19 designates a node number of each element obtained by the division.

Ushiro, col. 8, lines 45-49. In other words, the input area has been partitioned into a number of elements that form the finite element division. There is ***no disclosure*** of partitioning that finite element division shown in FIG. 5 of Ushiro into partitions.

Furthermore, step 15 of FIG. 4 of Ushiro generates linear equations based upon the entire finite element area that has been created. By contrast, original claim 1 recited "computing a preconditioner for the coefficient matrix A that is compatible with the linear system of equations and that provides at least basis function support over at least two mesh elements, where coupling of the preconditioner between partitions is only through basis functions at the partition boundaries". In other words, the operation of computing uses the partition boundaries. Not only is there no disclosure of "partitions" in Ushiro, there is no disclosure in Ushiro that computations are performed relative to boundaries between the partitions.

Consequently, independent, original claim 1 was patentable over Ushiro. Independent, original claims 9 and 16 recite subject matter similar to the subject matter in claim 1, and therefore original claims 9 and 16 were patentable over Ushiro. For example, original claim 9 recited "generating a mesh representation of the physical entity, the mesh representation comprising mesh elements", "computing a linear system matrix A of coefficients by computing interactions between simple functions defined over sets of mesh elements", "partitioning the mesh representation into a plurality of partitions separated by partition boundaries", and "computing a preconditioner for the coefficient matrix A that is compatible with the linear system of equations and that provides at least basis function support over at least two mesh elements, where coupling of the preconditioner between partitions is only through basis functions at the partition boundaries". Original claim 17 recited the subject matter of "a generator to output a mesh representation of the physical entity, the mesh representation comprising mesh elements", "a first computation function to compute a linear system matrix A of coefficients by computing interactions between simple

functions defined over sets of mesh elements", "a partitioner to partition the mesh representation into a plurality of partitions separated by partition boundaries", and "a second computation function to compute a preconditioner for the coefficient matrix *A* that is compatible with the linear system of equations and that provides at least basis function support over at least two mesh elements, where coupling of the preconditioner between partitions is only through basis functions at the partition boundaries".

The dependent claims are all allowable at least by virtue of their dependency from allowable independent claims. Thus, the individual merits of the dependent claims need not be discussed at this juncture. It is noted, however, that claims such as claim 5 are not disclosed by Ushiro. Claim 5 recites the following:

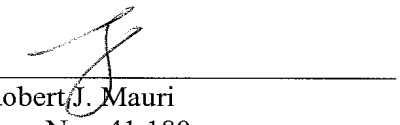
> A method as in claim 4, further comprising sorting indices of basis functions in the matrices *A* and *K* so that all internal elements appear first, grouped according to their respective partitions, followed by all boundary elements, and where a resulting preconditioning matrix *K* for n partitions has the form:
>
> $$K = \begin{bmatrix} [Ka_1] & & & & \\ & [Ka_2] & & & [Kb] \\ & & \ddots & & \\ & & & [Ka_n] & \\ & [Kc] & & & [Kd] \end{bmatrix},$$
>
> where the sub matrix *Ka* is the block diagonal matrix created by the union of the matrices of internal element interactions Ka_1 through Ka_n, *Kd* represents the interactions between the boundary elements, and *Kb* and *Kc* are the interactions between the internal and boundary elements.

As Ushiro does not disclose partitions of a mesh representation, Ushiro cannot disclose the subject matter of claim 5, which is directed at least in part to using such partitions.

Based on the foregoing arguments, it should be apparent that claims 1-24 are thus allowable over the reference(s) cited by the Examiner, and the Examiner is respectfully

requested to reconsider and remove the rejections. The Examiner is invited to call the undersigned attorney for any issues.

Respectfully submitted:



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